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FASTENER MEANS

The present invention relates to a material that can function as a fastener surface for the male component of a hook and loop fastener system, to a method of producing said material, and to an absorbent article, such as a diaper, in which the material is used as fastener means, and to a use of said material as female component in a hook and loop fastener system in an absorbent article.

In absorbent articles, such as diapers and incontinence guards for instance, the article is often secured to the wearer with the aid of a hook and loop fastener system. Such fastener means comprise a male and a female component, where the former is comprised of hooks and the latter is comprised of loops. These two fastener components can be fastened together and thereafter separated from one another.

The fastener devices comprise loops and hooks formed on one side of a fibre tape which is bonded to a carrier tape. The opposite surface of the carrier tape is suitably adhesive, so as to enable the tape to be fastened easily to an article.

The described two-layer construction that includes a carrier is necessary in order to ensure that the fastener device will be sufficiently strong and can be fastened to an absorbent body, e.g. glued thereto.

Known loop-carrying tape material is formed, e.g., by gluing a loop-carrying fibrous web to a carrier web, by needling loops from a fibrous web through a carrier web, or by melting one surface of a loop-carrying fibrous web that includes hot hotmelt fibres , so as to obtain a coherent carrier surface. Such materials are described in, for instance, EP-A2-0780505, WO96/04812, WO95/33390, WO92/20251, US-A-3,694,867, EP-A2-0258015, WO95/17111 and EP-A1-0765616.

One drawback with such fastener devices is that the laminate construction is not cost-effective, due to material consumption on the one hand and to the fact that several process steps are required on the other hand. Furthermore, the fastener device can be unnecessarily rigid and therefore uncomfortable, and may even chafe the wearer's skin. However, fastener devices of this type known hitherto have always required a carrier in order to be used and applied to an absorbent article, such as a diaper or an incontinence guard, and to bind together sufficiently strongly to ensure that the loops will not separate from the material as a hook and loop fastener is fastened to the material and then released and refastened at one and the same place or at some other place.

The object of the present invention is to provide a fastener device which is less expensive and more pliable than earlier known devices and the material of which is sufficiently stable for use as a female component to the male component of a hook and loop system.

This object is achieved in accordance with the invention with a fastener device that consists of a nonwoven fabric comprised of a carded fibrous web of functional polymer fibres and binding fibres that are bound together mechanically by needling. Additional binding is effected by partially melting the binder fibres. This results in a relatively dense material that has a sufficiently open structure to enable the male component of a hook and loop system to fasten therein. The fastener device is also sufficiently stable to prevent the fibres from being torn away from the surface as the hook component of the fastener is released. It is also sufficiently stable for the hook component of the fastener to be fastened, released from the fastener device and moved to a new position thereon.

The nonwoven fabric can thus be used instead of the conventional looped female component of a hook and loop fastener system. The nonwoven fabric, however, has no loops. On the other hand, the fastener surface is slightly rugged.

The carded fibre mixture will conveniently comprise 10-25% binding fibres and 75-90% functional fibres. The functional fibres will preferably consist of a mixture of two or more types of fibre, suitably 40-60% of one type and 60-40% of another type. The functional fibres are either crimped single-component fibres or spiralled bi-component fibres or multi-component fibres of the side-by-side type. There may be used a mixture of several types of crimped fibres, crimped and spiralled fibres, or several types of spiralled fibres. The spiralled fibres may have already be spiralled when preparing the fibre mixture to be carded and needled. It is also possible to use multi-component fibres of the side-by-side type that are spiralled during manufacture of the fastener device, conveniently when applying heat so as to partially melt the binding fibres.

It is also possible to use different polymer materials in the fibres of the inventive fastener device. Polyester fibres and polypropylene fibres are preferred. In bi-component fibres or multi-component fibres there can be used two types of polyester that have mutually different melting and expansion coefficients, or, e.g., polyester as one component and another polymer material, e.g. polypropylene, as other components. The binding fibres may comprise bi-component fibres of polypropylene and polyethylene.

Different types of functional polyester fibres having varying lengths, thicknesses, etc., may be used in the manufacture of the inventive fastener device. A suitable thickness of the functional fibres is 1-6 dn, particularly 1.5-6 dn. When using only one type of fibre, such as polyester type fibres, fibres of two different thicknesses may be mixed together. A suitable length of both binding fibres and functional fibres is 30-80 mm, preferably 40-70 mm and then particularly about 60 mm.

Spiralled fibres may also be included in the mixture, to create a surface structure.

The polyester fibre fabric according to the invention can be used directly as fastener means and glued directly to a diaper for instance, in the absence of an intermediate carrier.

According to one preferred embodiment of the invention, the polyester nonwoven material includes spiralled fibres. The spiralled fibres that can be used in the inventive fastener device are suitably of the same type as those described in SE 9604833-5. These fibres are comprised of heat-crimped, spiralled, elastic thermoplastic multi-component fibres, preferably bi-component fibres. The components in the fibres are suitably disposed side-by-side. As the fibres are heat-treated the various components shrink to mutually different extents and thereby form the spiralled fibre.

In accordance with the invention, binding of the material can be further improved by calendering the material, i.e. with the aid of pressure and heat. Smooth-calendering is used in particular on one side of the material.

The inventive nonwoven fabric will now be described with reference to particular embodiments thereof and also with reference to the accompanying drawings, in which
Figs. 1-7 are schematic illustrations of the various steps that are carried out when testing the adhesiveness or holding strength of a hook and loop system;
Fig. 8 is a schematic view from above of a diaper in which the inventive nonwoven fabric is used as a tape landing zone system; and
Figs. 9 and 10 show parts of a diaper or incontinence guard that include a replaceable absorbent part.

Manufacture of the inventive fastener device is commenced by forming a nonwoven fabric from binding fibres and functional fibres. These fibres are then bound mechanically, suitably by needling, until there is obtained a relatively dense material that has a structure which is sufficiently open for the male component of a hook and loop fastener system to fasten therein and which is sufficiently stable to prevent an excessive number of fibres being loosened from the fastener device as the male

component of said device is pulled away. Needling imparts to the material a slightly rugged surface that functions as a fastening surface. The material is then generally equilateral. The material is then heated so as to partially melt the binding fibres and to hold the fastener device together. Any multi-component fibres of the side-by-side type present will be spiralled in this heating process. As the fibres spiral, the needled nonwoven fabric will shrink to some extent and the ruggedness of the surface increase. One side of the material is then suitably smooth calendered. The smooth surface of the material thus obtained facilitates gluing of said surface to an article. This smooth calendering of said surface shall not be confused with the heat smelting process described in, e.g., EP-A1-0 780 505 for forming a carrier surface.

It is necessary to establish the extent to which needling shall be carried out, by experimenting with the material produced. In addition to a subjective assessment of the density of the material, its adhesiveness, and integrity, the shear force and peeling force required to release the fastener device from a hook-carrying part of the device can be measured in accordance with the following.

In the following description of the tests carried out, the female and male components of the hook and loop fastener systems are referred to as loop components and hook components respectively, regardless of whether these fastener parts present respectively loops and hooks as in a typical loop and hook fastener system or whether they lack the presence of loops, for instance, such as in the case of the inventive nonwoven fabric that includes a fastener surface.

DESCRIPTION OF EMBODIMENTS

Tests were carried out with the following mixtures.

PARAMETERS	Test 1, 08-370	Test 2, 08-378	Test 3, 08-379
Binding fibers %	15 % 4 dn bico	20 % 2 dn bico	20 % 2 dn bico
Supplier	UNITIKA	HOECHST	HOECHST
Type	Melty 4080	Trevira T 254	Trevira T 254
Functional fibres	50 % 3 dn	40 % 3 dn	40 % 6dn conj.hollow
Supplier	HOECHST	HOECHST	NAN YA
Type	Trevira T 290	Trevira T 290	
Functional fibres	35 % 1,5 dn	40 % 3 dn spiral	40 % 3 dn spiral
Supplier	HOECHST	RHONE-POULENC	RHONE-POULENC
Type	Trevira T 290	Tergal X443	Tergal X403

Tergal X443 and Tergal 403 are bi-component fibres of the side-by-side type that spiral when heated. The two components are comprised of two types of polyester that have mutually different melting points. NAN YA is a fibre that has already been spiralled and which also comprises bi-component polyester of the side-by-side type. All of the binding fibres are of the kind that includes a polyester core and a co-polyester casing.

As will be seen, two crimped polyester fibres of mutually different thickness were used in Test 1. In Test 2, there was used a crimped polyester fibre in mixture with a bi-component fibre that spiralled when heated. In Test 3, there was used a polyester fibre that had already spiralled in mixture with a bi-component fibre that spiralled when heated. A bi-component fibre of the type that includes a core which melts at high temperature and a casing which melts at low temperature were used as binding fibre in

all tests. The material was heated until the binding fibre casing melted, but was stopped before the core melted.

Samples	Description
EKL, loop material	Standard knitted polyester fabric coated with polypropylene, weight per unit area 90g/m^2 (PET 47.5, PP 42.5 g/m^2)
08-370 K	Smooth calendered, long hotmelt fibres
08-378, thick fibres	Side-by-side fibres that shrink and spiral in-line
08-379, fine fibres	Side-by-side fibres that shrink and spiral in-line

DETERMINING THE SHEAR FORCE OF A HOOK AND LOOP FASTENER SYSTEM

Principle

The hook material and the loop material are joined together in a controlled fashion. The shear force is then measured with a tensile testing device.

Sample preparation

- Choose sample combination according to Fig. 1. MD denotes machine direction and CD denotes cross direction.
- Punch out the loop samples, 50 x 60 mm and mark with a pen according to Figs. 2A, B. Fig. 2A shows a roll of loop material 1 and Fig. 2B shows a role of hook material 2.
- Cut out the hook samples, 25 x 80 mm, and mark with an asterisk and arrow respectively, to show respective directions on the sample.

- Make a mark 30 mm in from the edge of the hook sample in accordance with Fig. 3A. The CD-directions shall be tested primarily.

Procedure

- Place the hook sample 2 carefully over the loop sample 1. The contact surface shall measure 30 x 25 mm. See Fig. 3A.
  Place the hook and loop sample 2 and 1 respectively in the roll apparatus and allow the pressure roll 3 to roll forwards and backwards one time (one cycle); see Fig. 4.
- Place the whole of the sample in the tensile testing device 4 with the hook material 2 in the upper clamp 5 and the loop material 1 in the lower clamp 6, as shown in Fig. 5. The materials are pulled in the direction of the arrow F.
- Continue with the test until the materials are fully "delaminated".

Calculations and results

T_{max}	=	Shear force, N/cm^2
F_{max}	=	The highest force detected during "delamination", N
l	=	The length of the contact surface, mm
b	=	The width of the contact surface, mm

$$T_{max} = \frac{F_{max} \times 100}{l \times b}$$

DETERMINING THE DELAMINATING FORCE OF A HOOK AND LOOP FASTENER SYSTEM

Principle

The hook material and the loop material are joined together in a controlled fashion. The delaminating force is then determined with the aid of a tensile testing device with the material at 90°.

Sample preparation

- Select a sample combination according to Fig. 1.
- Punch out the loop samples 1, 50 x 60 mm, and mark with a pen according to Fig. 2A.
- Clip/cut out the hook samples 2, 25 x 80 mm, and mark with a star and an arrow respectively, so as to show respective directions on the sample according to Fig. 2B.
- Make a mark 30 mm from one edge of the hook sample 2 - see Fig. 3B. The CD directions shall be tested primarily.

Procedure

- Place over the hook sample 2 a piece of tape 7 which is sufficiently large to leave free a surface measuring 25 x 30 mm.
- Place the hook sample 2 over the loop sample 1. Leave 10 mm of the loop strip 3 for fastening the strip in the clamp; see Fig. 3B.
- Place the hook sample 2 + the loop sample 1 in the roll apparatus and allow the pressure roll 3 to roll forwards and backwards one time (one cycle) - see Fig. 4. Begin to roll in the direction shown in the Figure.
- In order to generate a defined shear force, place the outwardly projecting part of the loop material 1 in a clamp 8 and the outwardly projecting part of the hook material in a clamp 9, with a weight of 1 kg.
- Allow the weight to hang freely for 10 seconds; see Fig. 6.

- Place the sample in the tensile testing device 4 with the hook component 2 in the upper clamp 5 and the loop component in the lower clamp 6.
- Carry out the test on the two materials at an opening angle of 180°; see Fig. 7.
- The delaminating force can also be determined with repeated opening and closing of the two components if so desired. This can only be done if no deformation occurs in the material during the test.

Calculation and results

The method measures the highest peaks (max. 20) during the test.

F_{max} N/25 mm	=	The highest peak during the test
F_{med} N/25 mm	=	The mean value of all peaks during the test

In the described tests, the shear force with respect to the loop material will preferably lie between 40 and 100 N/7.5 cm^2 and the delaminating force between 2 and 5 N/25 mm (mean load) and between 3 and 8 N/25 mm (peak load) respectively. Excessively high values mean that it is difficult to loosen the hook and loop components from one another without tearing said components or without removing a component from the underlying backing sheet, whilst excessively low values indicate insufficient fastening ability or holding strength. It will be seen from the following that the inventive material has the properties desired and surpasses the reference material EKL in several respects.

The results are shown in Table 2 below.

Table 2

Fastener Device	Weight per unit area	Shear force, N/7.5 cm^2 Peak load, C:3			Delaminating force, N/25 mm Mean load, C:3			Delaminating force, N/25 mm Peak load, C:3		
	g/m^2	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
EKL	90	70			3.5			5.5		
08-370K	60	82	89	75	3	4	3	5	6	4
	80	92	101	80	3.5	4	3	5.5	6.5	4.5
	100	47	57	21	2.5	3	2	4	6.5	3
08-378	80	73	77	68	4	5	3	6	7	5
08-379	80	43	48	40	2	2	1.2	3	4	2

The best shear force result was obtained with sample 08-370K, followed by 08-378, although this latter gave a somewhat higher delaminating force.

All tests were carried out with standard hook C200 from 3M.

Fig. 8 is a schematic illustration of a diaper with which the inventive fastener material can be used. The diaper includes an absorbent sheet which is disposed between a liquid-permeable inner sheet that lies proximal to a wearer in use and a liquid impermeable outer sheet, or backing sheet, which lies distal from the wearer in use. The diaper has a generally rectangular shape and is delimited by two short sides 10, 11 and two long sides 12, 13. Two fastener tapes that include hook material 2 are fastened to the outside of the diaper, at one short end 10, such that a free part of each fastener tape forms an extension of said short side, wherewith the hook material faces in the same direction as the inside surface of the diaper. Loop material 1 according to the invention is fastened to the outside of the diaper at the other short end 11, in each corner thereof. When placing the diaper on a wearer, the centre part of the diaper is curved around the wearer's crotch, so that the short sides 10, 11 will lie around the wearer's waist. The diaper is fastened by applying the tapes that include hook material 2 to the tapes that include loop material 1. By way of alternative, a strip of loop material can be placed along the full length of the short side, instead of using two pieces of loop material along the length of the short side 11. This is shown by a broken line in Fig. 8.

The inventive nonwoven fabric may also be used in the type of diaper or incontinence guard described in US-A-5,549,593, for instance. This type of diaper is illustrated in Figs. 9 and 10 and includes an absorbent part 14, the actual diaper, which is replaceable and secured to a belt 15 around the wearer's waist. The absorbent part 14 includes an absorbent layer disposed between a liquid-permeable inner sheet, or top sheet, which lies proximal to the wearer in use, and a liquid-impermeable outer sheet, or backing sheet, which lies distal from the wearer in use. Two strips of hook material 2 are disposed along each short side 10, 11 of the absorbent part 14, on the outer side thereof. A nonwoven fabric 1 that includes an inventive fastener surface in the form of loop material is provided on the inside of the belt 15. The short ends 10, 11 of the absorbent part 14 can be inserted in beneath the belt, wherewith the hook material 2 extending along the outer edges of the absorbent part coacts with the loop material 1

on the inside of the belt 15 to secure the diaper to the wearer. Alternatively, the loop material 1 may be provided on the absorbent part 14 and the hook material 2 on the belt 15. Another variant is to provide a fastener surface (either the male or female component) on the outside of the belt 15, and to provide the strip that carries either hook material or loop material on the inside of the absorbent body 14, i.e. on that side of said body that shall face towards the wearer in use. That part of the hook and loop fastener system provided on the belt 15 may either be a continuous strip, as shown in Fig. 10, or comprise several smaller pieces.

It will be understood that the uses described above have been given only by way of example and in no way limit the scope of the invention. The inventive fastener device can be used in all cases where a hook and loop fastener system that includes a male and female component is used.